

SMOKY HILL/SALINE RIVER BASIN TOTAL MAXIMUM DAILY LOAD

Water Body: Kanopolis Lake
Water Quality Impairment: Eutrophication

Subbasin: Middle Smoky Hill

Counties: Barton, Ellis, Ellsworth, Gove, Lincoln, Ness, Rice, Rush, Russell, Sheridan, and Trego

HUC 8: 10260006 **HUC 11 (14):** **010** (010, 020, 030, 040, 050, 060) (Figure 1)
020 (010, 020, 030, 040)
030 (010, 020, 030, 040)
040 (010, 020, 030, 040, 050, 060, 070)
050 (010, 020, 030, 040, 050, 060, 070)
060 (010, 020, 030, 040, 050, 060, 070, 080)

10260007 **010** (010, 020, 030, 040)
 020 (010, 020, 030, 040)
 030 (010, 020, 030, 040, 050)
 040 (010, 020, 030, 040, 050)

Ecoregion: Central Great Plains, Smoky Hills (27a)
Central Great Plains, Rolling Plains and Breaks (27b)

Drainage Area: Approximately 2,414 square miles.

Conservation Pool: Area = 3,742 acres
Watershed Area: Lake Surface Area = 413:1
Maximum Depth = 10.0 meters (32.8 feet)
Mean Depth = 4.0 meters (13.1 feet)
Retention Time = 0.12 years (1.4 months)

Designated Uses: Primary and Secondary Contact Recreation; Expected Aquatic Life Support; Drinking Water; Food Procurement; Irrigation

Authority: Federal (U.S. Army Corps of Engineers), State (Kansas Water Office)

2002 303(d) Listing: Smoky Hill/Saline River Basin Lakes

Impaired Use: All uses are impaired to a degree by eutrophication

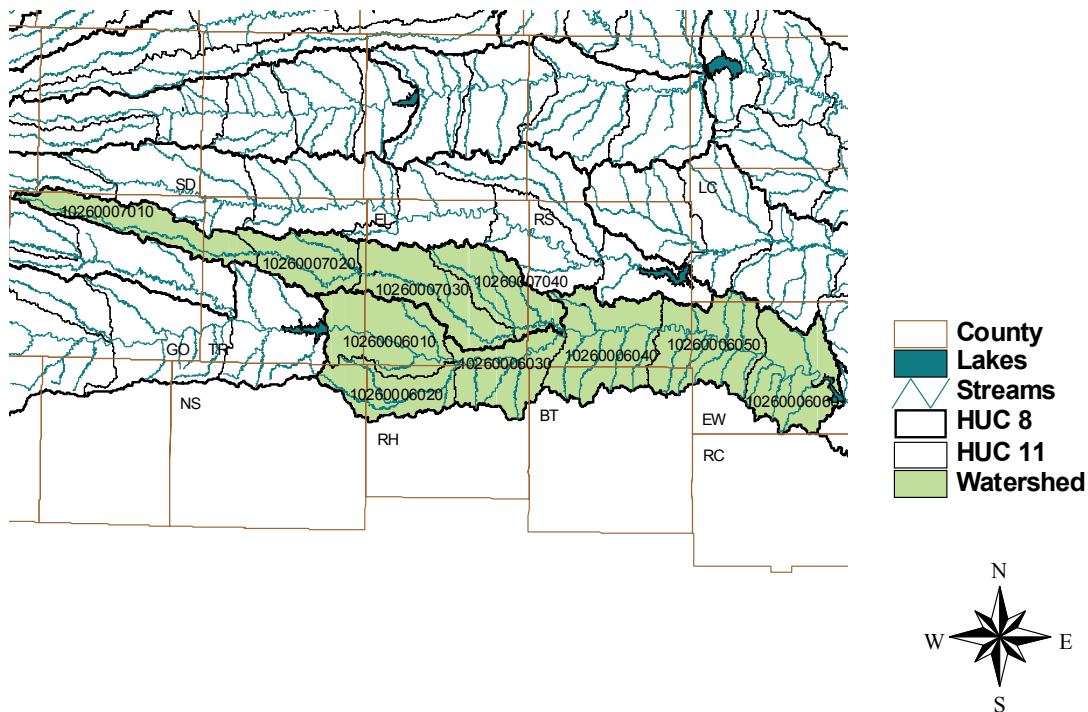
Water Quality Standard: Nutrients - Narrative: The introduction of plant nutrients into streams, lakes, or wetlands from artificial sources shall be controlled to

prevent the accelerated succession or replacement of aquatic biota or the production of undesirable quantities or kinds of aquatic life. (KAR 28-16-28e(c)(2)(B)).

The introduction of plant nutrients into surface waters designated for primary or secondary contact recreational use shall be controlled to prevent the development of objectionable concentrations of algae or algal by-products or nuisance growths of submersed, floating, or emergent aquatic vegetation. (KAR 28-16-28e(c)(7)(A)).

Figure 1

Kanopolis Lake HUC 11s



2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

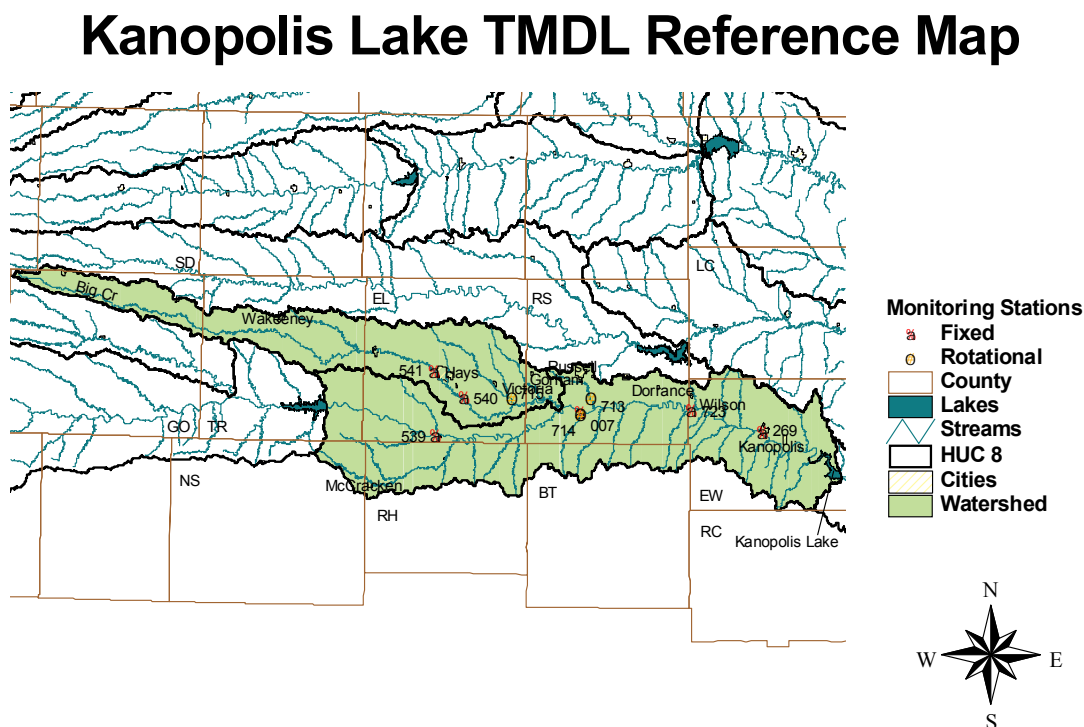
Level of Eutrophication: Very Eutrophic, Trophic State Index = 61.83

Lake Chemistry Monitoring Sites: Station 016001 in Kanopolis Lake (Figure 2).

Period of Record Used: Five surveys during 1988 - 2000

Stream Chemistry Monitoring Site: Station 269 at Ellsworth (Smoky Hill River)
Period of Record Used: 1985 - 2002
Flow Record: Smoky Hill River at Ellsworth, KS (USGS Gage 06864500)

Figure 2



Current Condition: In 2000, Kanopolis Lake was very eutrophic. The lake had chlorophyll a concentrations averaging $24.2 \mu\text{g/L}$, a Total Phosphorus concentration of $80 \mu\text{g/L}$, a Total Kjeldahl Nitrogen concentration of 0.91 mg/L , and a nitrate concentration of 0.28 mg/L (Appendix A). Light was indicated to be the primary limiting factor due to clay turbidity (Appendix B). Nitrogen was a secondary limiting factor. The chlorophyll a to total phosphorus yield was moderate. Based on the load duration curves in Appendix C, the exceedences are at higher and lower flows implying that both nonpoint and point source pollution respectively are contributing factors in the Kanopolis watershed.

Prior to this time, Kanopolis Lake was slightly eutrophic with a Trophic State Index of 50.97. The average chlorophyll a concentration was $8.0 \mu\text{g/L}$, and the total phosphorus concentration was $45 \mu\text{g/L}$. The Total Kjeldahl Nitrogen concentrations averaged 0.63 mg/L ; nitrate concentrations averaged 0.15 mg/L ; and nitrite was below the detection limit.

The Trophic State Index is derived from the chlorophyll a concentration. Trophic state assessments of potential algal productivity were made based on chlorophyll a concentrations, nutrient levels and values of the Carlson Trophic State Index (TSI). Generally, some degree of eutrophic conditions is seen with chlorophyll a concentrations over 7 $\mu\text{g/l}$ and hypereutrophy occurs at levels over 30 $\mu\text{g/l}$. The Carlson TSI, derives from the chlorophyll concentrations and scales the trophic state as follows:

1. Oligotrophic TSI < 40
2. Mesotrophic TSI: 40 - 49.99
3. Slightly Eutrophic TSI: 50 - 54.99
4. Fully Eutrophic TSI: 55 - 59.99
5. Very Eutrophic TSI: 60 - 63.99
6. Hypereutrophic TSI: ≥ 64

Interim Endpoints of Water Quality (Implied Load Capacity) at Kanopolis Lake over 2008 - 2012:

In order to improve the trophic condition of the lake from its current Very Eutrophic status, the desired endpoint will be to maintain summer chlorophyll a concentrations below 12 $\mu\text{g/L}$. Total Nitrogen concentration in the lake should be maintained below 0.62 mg/L. A regression of 2000 - 2001 lake data and 1997 - 2000 wetland data was used to determine the current, in-lake nitrogen concentration and to calculate how much of a nutrient reduction was need to meet water quality standards.

Current Condition and Reductions for Kanopolis Lake

Parameter	Current Condition	TMDL	Percent Reduction
Total Phosphorus Load (lb/year)	370,796	73,920	80.1 %
Total Phosphorus Concentration ($\mu\text{g/L}$)	80	43	46.3 %
Chlorophyll a ($\mu\text{g/L}$)	24.2	< 12	50.4 %
Total Nitrogen Concentration (mg/L)	1.19	< 0.62	47.9 %

3. SOURCE INVENTORY AND ASSESSMENT

NPDES: Twenty-six permitted waste treatment facilities are located within the watershed (Figure 3). Eighteen are non-overflowing lagoons that are prohibited from discharging and may contribute a nutrient load under extreme precipitation events (flow durations exceeded under 5 percent of the time). Such events would not occur at a frequency or for a duration sufficient to cause an impairment in the watershed. Below is a list of the non-overflowing facilities.

Non-overflowing Facilities in the Kanopolis Watershed

Kansas Permit Number	Facility Name	Type	Wasteload Allocation TN & TP
C-SA03-NO01	BEAR HOUSE CAFE & TRUCK STOP	2-cell Lagoon	0 lb/day
C-SA21-NO01	SERVICE OIL COMPANY-INTERSTATE HOUSE	2-cell Lagoon	0 lb/day
C-SA21-NO02	WATERING HOLE	1-cell Lagoon	0 lb/day
C-SH07-NO01	STUCKEY'S DAIRY QUEEN - ELLSWORTH	2-cell Lagoon	0 lb/day
I-SH16-NP04	ELLIS CO. HIGHWAY DEPT.	3-cell Containment Basin	0 lb/day
M-SH05-NO01	DORRANCE MWTP	2-cell Lagoon	0 lb/day
M-SH12-NO02	USD #292 GRAINFIELD-WHEATLAND SCHOOL	2-cell Lagoon	0 lb/day
M-SH12-NR02	KDOT. GOVE CO. REST AREA I-70	2-cell Lagoon	0 lb/day
M-SH14-NO01	GRINNELL MWTP	2-cell Lagoon	0 lb/day
M-SH19-NO01	KANOPOLIS MWTP	2-cell Lagoon	0 lb/day
M-SH19-NO02	KDWP - KANOPOLIS (EAST)	2-cell Lagoon	0 lb/day
M-SH19-NO03	KDWP - KANOPOLIS (SOUTH SHORE)	2-cell Lagoon	0 lb/day
M-SH20-NO01	LIEBENTHAL MWTP	4-cell Lagoon	0 lb/day
M-SH31-NR02	KDOT. RUSSELL CO. REST AREA	2-cell Lagoon	0 lb/day
M-SH37-NO01	VICTORIA MWTP	3-cell Lagoon	0 lb/day
M-SH38-NR02	KDOT. TREGO CO. REST AREA	2-cell Lagoon	0 lb/day
M-SH50-NO01	MUNJOR IMPROVEMENT DISTRICT	3-cell Lagoon	0 lb/day
M-SH34-NO01	SCHOENCHEN MWTP	3-cell Lagoon	0 lb/day

The remaining eight waste treatment plants have the potential to contribute to the nutrient load. Based on the design flow and the estimated loading from the lagoons and mechanical plants, the current wasteload is 64,897 pounds per year of total phosphorus and 261,050 pounds per year of total nitrogen. For Hays MWTP, the design flow and the average, the 2002 annual total phosphorus and total nitrogen concentrations were used in calculating the load (Appendix D).

Waste Treatment Plants in the Kanopolis Lake Watershed

Facility	Receiving Stream	Design Flow (MGD)	Type
HAYS WWTF	BIG CREEK VIA CHETOLAH CREEK	2.80	Activated Sludge
RUSSELL WWTP	FOSSIL CREEK VIA UNNAMED TRIBUTARY	1.40	4-cell Lagoon
ELLSWORTH WWTF	SMOKY HILL RIVER VIA OAK CREEK	0.50	3-cell Lagoon
WAKEENEY MWTP	BIG CR VIA UNNAMED TRIB.	0.43	Trickling Filter
ELLIS WWTF	BIG CREEK	0.30	UV Disinfection
WILSON MWTP	U. SMOKY HILL R	0.09	Trickling Filter, Lagoon in construction
GORHAM MWTP	U. SMOKY HILL R BIG CR	0.06	3-cell Lagoon
MC CRACKEN MWTP	SMOKY HILL RIVER/BIG TIMBER CREEK	0.04	3-cell Lagoon

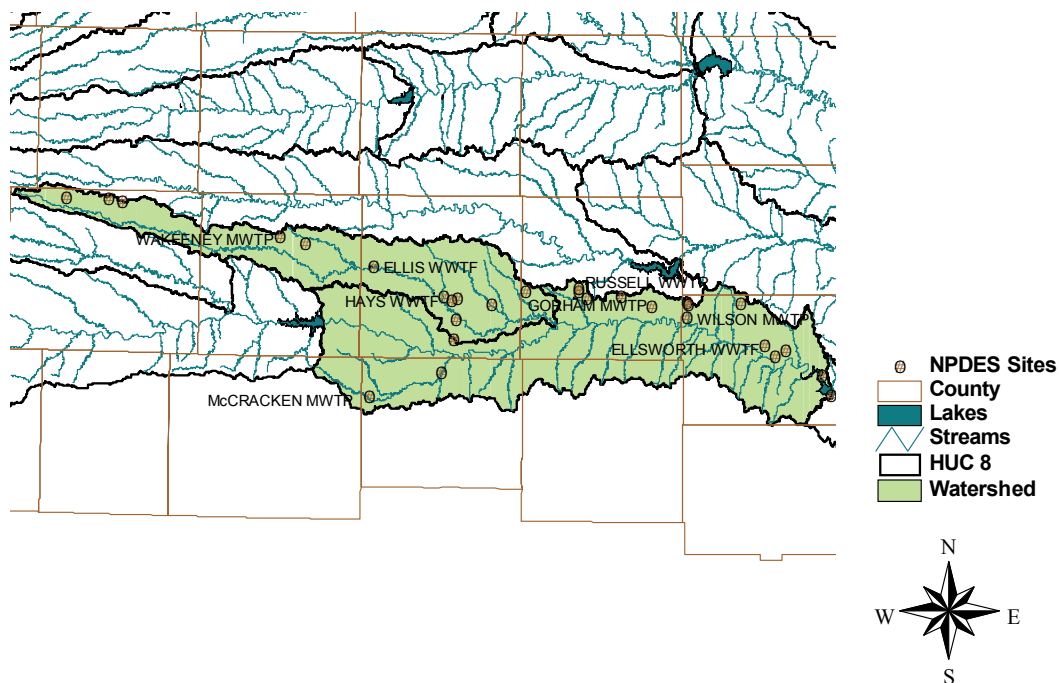
The point source contribution is derived from monitoring data from the waste treatment plants and other point source pollution contributors. When effluent discharge data is not available, the following concentrations are used to calculate the waste load allocations for waste treatment plant lagoons and municipal mechanical plants:

Average Concentration in Municipal Facilities that Meet Baseline Design

Facility Type	Total Phosphorus	Total Nitrogen
Waste Treatment Plant Lagoon	2.0 mg/L	7.0 mg/L
Mechanical Plant – Trickling Filter	3.5 mg/L	20.0 mg/L
Mechanical Plant – Activated Sludge only fully nitrify	3.5 mg/L	25.0 mg/L
Mechanical Plant – Activated Sludge fully nitrify and de-nitrify	3.5 mg/L	10.0 mg/L

Figure 3

Kanopolis Lake NPDES Sites

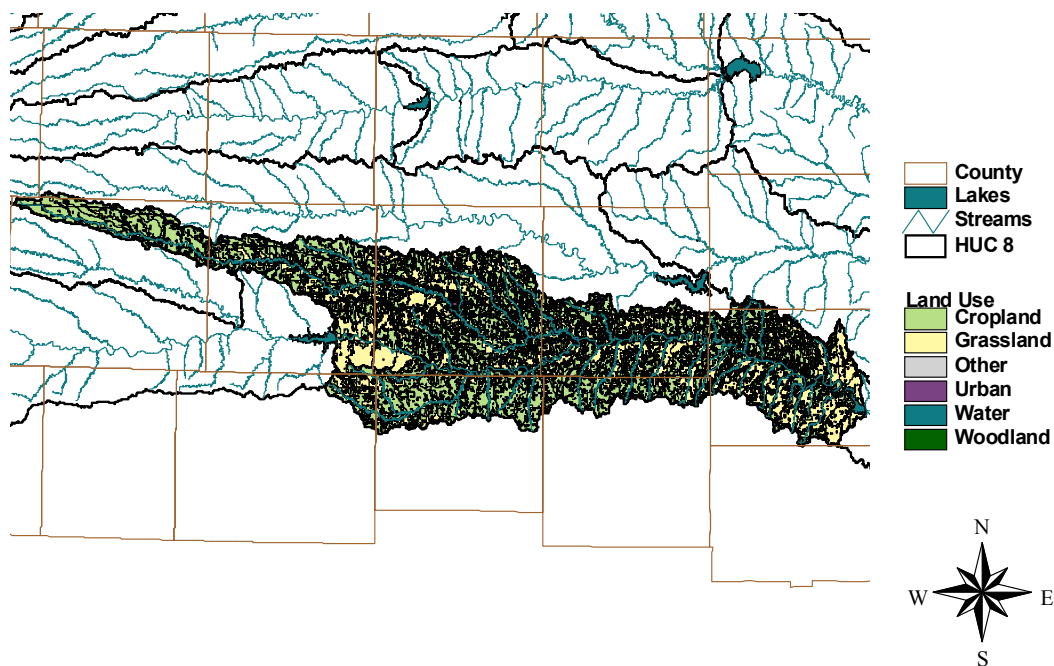


Land Use: The watershed around Kanopolis Lake has a high potential for nonpoint source pollutants. An annual phosphorus load of 370,796 pounds per year is necessary to correspond to the concentrations seen in the lake.

One source of phosphorus and nitrogen within Kanopolis Lake is probably runoff from agricultural lands where phosphorus and nitrogen have been applied. Land use coverage analysis indicates that 56.5% of the watershed is cropland (Figure 4).

Figure 4

Kanopolis Lake Land Use



Phosphorus and nitrogen from animal waste are a potential contributing factor. Animal waste, from livestock waste management systems, may add to the phosphorus and nitrogen loads going into the lake (Figure 5). However, given the controls for the systems, animal waste coming from grazing areas is a more likely contributor. Forty-two percent of land around the lake is grassland. There are 41 beef, 26 swine, 46 dairy, one combination, one horse, two exotic, and one sheep animal feeding operations in the watershed. Five of these facilities are NPDES permitted, non-discharging facilities with 47,036 animal units. All permitted livestock facilities have waste management systems designed to minimize runoff entering their operations or detaining runoff emanating from their areas. Such systems are designed to retain the 25 year, 24 hour rainfall/runoff event, as well as an anticipated two weeks of normal wastewater from their operations. Such a rainfall event typically coincides with stream flows which are exceeded 1-5 percent of the time. Therefore, events of this type, infrequent and of short duration, are not likely to add to chronic impairment of the designated uses of the waters in this watershed. Requirements for maintaining the water level of the waste lagoons a certain distance below the lagoon berms ensure retention of the runoff from the intense, local storms events. In Ellis County, where many of the facilities are relatively close to the river, such an event would generate 4.9 inches of rain, yielding 3.8 to 4.6 inches of runoff in a day. Permit compliance data was examined. Potential animal units for all facilities in the watershed total 84,958

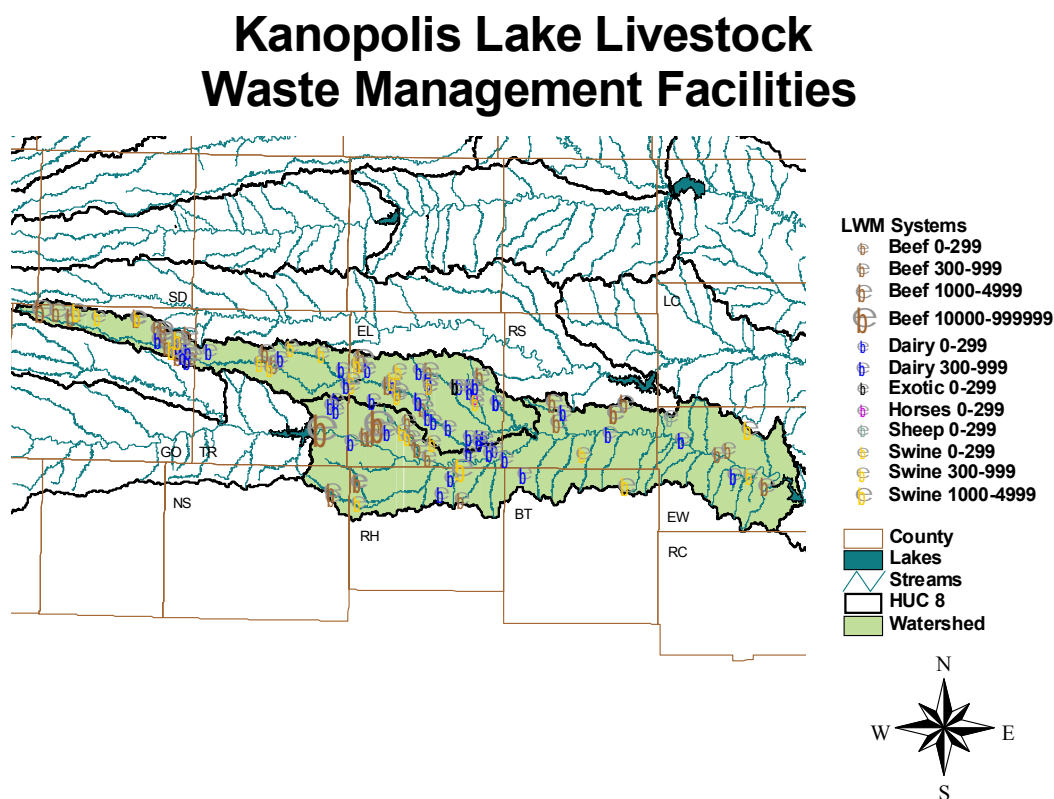
(active: 68,225 animal units; inactive: 16,733 animal units). The actual number of animal units on site is variable, but typically less than potential numbers.

Permitted Livestock Waste Management Systems in the Kanopolis Watershed

Kansas Permit Number	Livestock Waste Management System	Waste Load Allocation - TN & TP
A-SATR-BD01	Wakeeney Livestock Commission	0 lb/day
A-SHEL-C002	* Hays Feeders, Llc	0 lb/day
A-SHGO-C011	* Helendale Ranch	0 lb/day
A-SHRH-H001	Urban, Barry J.	0 lb/day
A-SHTR-C001	* Cedar Bluff Cattle Feeders	0 lb/day

* The facility is not in compliance with the existing permit. Corrective actions are being taken by the KDHE Livestock Management Program.

Figure 5



Most of the towns in the watershed anticipate a population decline except for Quinter, Collyer, Hays, Victoria, and Ellsworth. Less than one percent of the watershed is urban; stormwater runoff and urban fertilizer applications are a minor contributing factor. The average population density in the watershed is 16.7 people per square mile.

Population Trends for Towns in the Watershed

Town	% Change (2000 to 2020)	Town	% Change (2000 to 2020)
Brownell	-20.0%	Liebenthal	-14.5%
Collyer	2.1%	McCracken	-3.4%
Dorrance	-8.8%	Park	-3.4%
Ellis	-3.0%	Quinter	8.8%
Ellsworth	14.7%	Russell	-2.2%
Galatia	-19.0%	Schoenchen	-6.1%
Gorham	-15.4%	Susank	-8.5%
Grainfield	-4.0%	Victoria	15.9%
Grinnell	-6.2%	Wakeeney	-15.1%
Hays	13.4%	Wilson	-11.4%
Kanopolis	-2.2%		

A potential source is septic systems located around the lake. Failing septic systems can be a significant source of nutrients. The Ellsworth County has 1,036 septic systems, accounting for 31% of the sewage systems present in the county.

Contributing Runoff: The watershed's average soil permeability is 1.5 inches/hour according to NRCS STATSGO database. About 91.4% of the watershed produces runoff even under relatively low (1.5"/hr) potential runoff conditions. Runoff is chiefly generated as infiltration excess with rainfall intensities greater than soil permeabilities. As the watersheds' soil profiles become saturated, excess overland flow is produced. Generally, storms producing less than 0.5"/hr of rain will generate runoff from 4.9% of this watershed, chiefly along the stream channels.

Background Levels: The atmospheric phosphorus and geological formations (i.e., soil and bedrock) may contribute to phosphorus loads. Nutrients from wildlife waste are another contributing factor.

4. ALLOCATION OF POLLUTANT REDUCTION RESPONSIBILITY

While light is the limiting factor in Kanopolis Lake, Total Phosphorus is allocated under this TMDL, because a phosphorus reduction will have a large effect on the managing the algal community. The Load Capacity is 73,920 pounds per year of phosphorus and was calculated using the CNET model. More detailed assessment of sources and confirmation of the trophic state of the lake must be completed before detailed allocations can be made. The general inventory of sources within the drainage does provide some guidance as to areas of load reduction. Because of atmospheric deposition, initial allocations of nitrogen will be based on a proportional decrease in nitrogen between the current condition and the desired endpoint.

Point Sources: This impairment is associated with the Waste Treatment Plants. Ongoing inspections and monitoring of these NPDES sites will be made to ascertain the contributions that have been made by the source. These Waste Treatment Plants should comply with any future permit limits. The Wasteload Allocation should be at 50,331 pounds of total phosphorus per year, a 22.4% reduction in current estimated total phosphorus loading. The Total Nitrogen Wasteload Allocation is 261,050 pounds per year, a 5% reduction. (See Appendix E for the detailed Waste Load Allocations). As previously noted in the inventory and assessment section, sources such as non-discharging permitted municipal facilities and livestock waste management systems located within the watershed do not discharge with sufficient frequency or duration to add to an impairment in the lake.

Nonpoint Sources: Water quality violations are partially due to nonpoint source pollutants. Background levels may be attributed to atmospheric deposition and geological sources. The assessment suggests that cropland and animal waste contribute to the elevated total phosphorus concentrations in the lake. Generally a Load Allocation of 16,197 pounds of total phosphorus per year, leading to an 80% reduction, is necessary to reach the endpoint. A proportional decrease of 43% in nitrogen loading will allow the total nitrogen endpoint to be achieved.

Defined Margin of Safety: The margin of safety provides some hedge against the uncertainty of variable annual total phosphorus load and the chlorophyll a endpoint. Therefore, the margin of safety will be 7,392 pounds per year of total phosphorus taken from the load capacity subtracted to compensate for the lack of knowledge about the relationship between the allocated loadings and the resulting water quality. For nitrogen, the margin of safety will be an additional 5% reduction in nitrogen to ensure that the endpoint is reached.

State Water Plan Implementation Priority: Because Kanopolis Lake has a large regional benefit for recreation, this TMDL will be a High Priority for implementation.

Unified Watershed Assessment Priority Ranking: Kanopolis Lake lies within the Middle Smoky Hill (HUC 8: 10260006) with a priority ranking of 51 (Low Priority for restoration).

Priority HUC 11s: The HUC 11s (10260006050 and 10260006060) are adjacent to Kanopolis Lake, and thus the Middle Smoky Hill subwatershed should take priority.

5. IMPLEMENTATION

Desired Implementation Activities

There is a very good potential that agricultural best management practices will allow full use support to take place in Kanopolis Lake. Some of the recommended agricultural practices are as follows:

1. Implement soil sampling to recommend appropriate fertilizer applications on cropland.
2. Maintain conservation tillage and contour farming to minimize cropland erosion.
3. Install grass buffer strips along streams.
4. Reduce activities within riparian areas.
5. Implement nutrient management plans to manage manure application to land.

Implementation Programs Guidance

Nonpoint Source Pollution Technical Assistance - KDHE

- a. Support Section 319 demonstration projects for reduction of sediment runoff from agricultural activities as well as nutrient management
- b. Provide technical assistance on practices geared to establishment of vegetative buffer strips.
- c. Provide technical assistance on nutrient management in vicinity of streams.
- d. Update and implement nutrient and sediment abatement strategies.
- e. Develop a Watershed Restoration and Protection Strategy for HUC 10260006 and 10260007.

Livestock Waste Management - KDHE

- a. Take corrective actions to ensure that facilities comply with existing permits.

Water Resource Cost Share Nonpoint Source Pollution Control Program - SCC

- a. Apply conservation farming practices, including terraces and waterways, sediment control basins, and constructed wetlands.
- b. Provide sediment control practices to minimize erosion and sediment and nutrient transport.

Riparian Protection Program - SCC

- a. Establish or reestablish natural riparian systems, including vegetative filter strips and streambank vegetation.
- b. Develop riparian restoration projects.
- c. Promote wetland construction to assimilate nutrient loadings.

Buffer Initiative Program - SCC

- a. Install grass buffer strips near streams.
- b. Leverage Conservation Reserve Enhancement Program to hold riparian land out of production.

Extension Outreach and Technical Assistance - Kansas State University

- a. Continue to educate residents and landowners about nonpoint source pollution.
- b. Educate agricultural producers on sediment, nutrient, and pasture management.
- c. Educate livestock producers on livestock waste management and manure applications and nutrient management planning.
- d. Provide technical assistance on livestock waste management systems and nutrient management plans.
- e. Provide technical assistance on buffer strip design and minimizing cropland runoff.
- f. Encourage annual soil testing to determine capacity of field to hold phosphorus.

Time Frame for Implementation: Pollutant reduction practices should be installed within the priority subwatersheds during the years 2003-2008, with minor followup implementation, including other subwatersheds over 2008-2012.

Targeted Participants: Primary participants for implementation will be agricultural producers within the drainage of the lake. Initial work in 2003 should include local assessments by conservation district personnel and county extension agents to locate within the lake drainage:

1. Total row crop acreage
2. Cultivation alongside lake
3. Drainage alongside or through animal feeding lots
4. Livestock use of riparian areas
5. Fields with manure applications

Milestone for 2008: The year 2008 marks the midpoint of the ten-year implementation window for the watershed. At that point in time, sampled data from Kanopolis Lake should indicate evidence of reduced phosphorus and nitrogen levels in the conservation pool elevations relative to the conditions seen in 2000.

Delivery Agents: The primary delivery agents for program participation will be conservation districts for programs of the State Conservation Commission and the Natural Resources Conservation Service. Producer outreach and awareness will be delivered by Kansas State Extension.

Reasonable Assurances:

Authorities: The following authorities may be used to direct activities in the watershed to reduce pollutants.

1. K.S.A. 65-171d empowers the Secretary of KDHE to prevent water pollution and to protect the beneficial uses of the waters of the state through required treatment of sewage and established water quality standards and to require permits by persons having a potential to discharge pollutants into the waters of the state.
2. K.S.A. 2-1915 empowers the State Conservation Commission to develop programs to assist the protection, conservation and management of soil and water resources in the state, including riparian areas.
3. K.S.A. 75-5657 empowers the State Conservation Commission to provide financial assistance for local project work plans developed to control nonpoint source pollution.
4. K.S.A. 82a-901, et seq. empowers the Kansas Water Office to develop a state water plan directing the protection and maintenance of surface water quality for the waters of the state.
5. K.S.A. 82a-951 creates the State Water Plan Fund to finance the implementation of the *Kansas Water Plan*.
6. The *Kansas Water Plan* and the Smoky Hill/Saline Basin Plan provide the guidance to state agencies to coordinate programs intent on protecting water quality and to target those programs to geographic areas of the state for high priority in implementation.

Funding: The State Water Plan Fund annually generates \$16-18 million and is the primary funding mechanism for implementing water quality protection and pollutant reduction activities in the state through the *Kansas Water Plan*. The state water planning process, overseen by the Kansas Water Office, coordinates and directs programs and funding toward watersheds and water resources of highest priority. Typically, the state allocates at least 50% of the fund to programs supporting water quality protection. This watershed and its TMDL are a High Priority consideration.

Effectiveness: Nutrient control has been proven effective through conservation tillage, contour farming and use of grass waterways and buffer strips. The key to success will be widespread utilization of conservation farming and installation of buffer strips within the watersheds cited in this TMDL.

6. MONITORING

Additional data, to further determine source loading and mean summer lake trophic condition, would be of value prior to 2008. Further sampling and evaluation should occur once before 2008 and twice between 2008 and 2012. Some monitoring of tributary levels of nutrients will help direct abatement efforts toward major contributors.

7. FEEDBACK

Public Meetings: Public meetings to discuss TMDLs in the Smoky Hill/Saline Basin were held January 7 and March 5, 2003 in Hays. An active Internet Web site was established at <http://www.kdhe.state.ks.us/tmdl/> to convey information to the public on the general establishment of TMDLs and specific TMDLs for the Smoky Hill/Saline Basin.

Public Hearing: A Public Hearing on the TMDLs of the Smoky Hill/Saline Basin was held in Hays on June 2, 2003.

Basin Advisory Committee: The Smoky Hill/Saline Basin Advisory Committee met to discuss the TMDLs in the basin on October 3, 2002, January 7, March 5, and June 2, 2003.

Discussion with Interest Groups: Meetings to discuss TMDLs with interest groups include:
Smoky Hill River Task Force: January 22, February 27, April 16, and May 28, 2003

Milestone Evaluation: In 2008, evaluation will be made as to the degree of implementation which has occurred within the watershed and current condition of Kanopolis Lake. Subsequent decisions will be made regarding the implementation approach and follow up of additional implementation in the watershed.

Consideration for 303(d) Delisting: The lake will be evaluated for delisting under Section 303(d), based on the monitoring data over the period 2008-2012. Therefore, the decision for delisting will come about in the preparation of the 2012 303(d) list. Should modifications be made to the

applicable water quality criteria during the ten-year implementation period, consideration for delisting, desired endpoints of this TMDL and implementation activities may be adjusted accordingly.

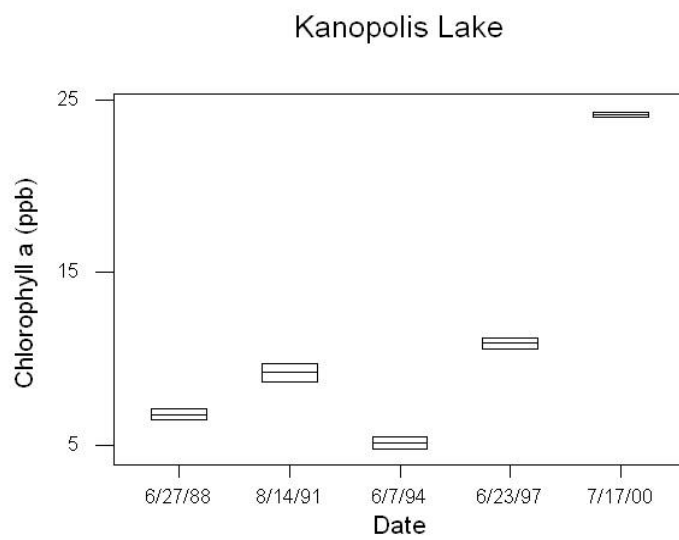
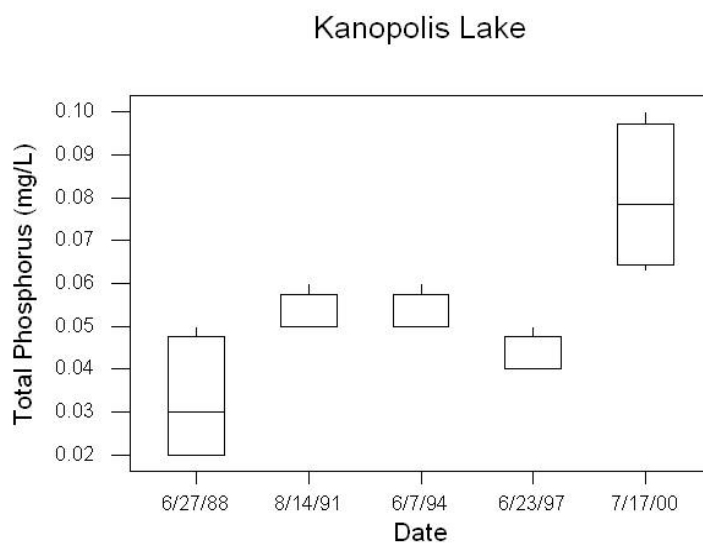
Incorporation into Continuing Planning Process, Water Quality Management Plan and the Kansas Water Planning Process: Under the current version of the Continuing Planning Process, the next anticipated revision will come in 2004 which will emphasize revision of the Water Quality Management Plan. At that time, incorporation of this TMDL will be made into both documents. Recommendations of this TMDL will be considered in *Kansas Water Plan* implementation decisions under the State Water Planning Process for Fiscal Years 2004-2008.

Bibliography

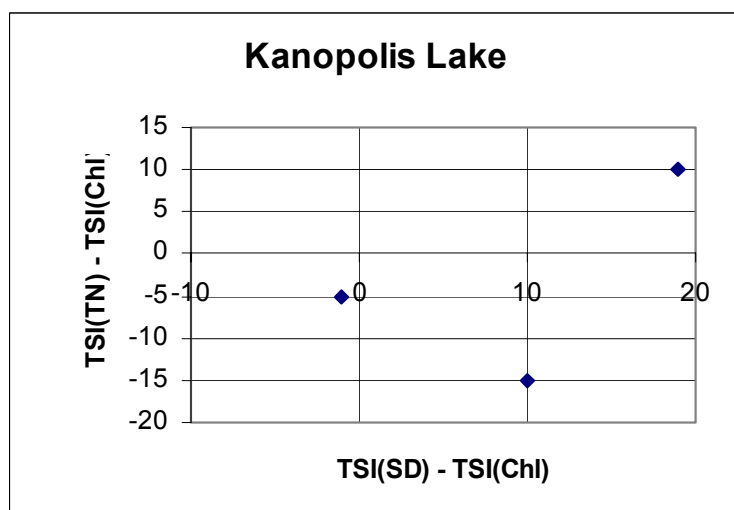
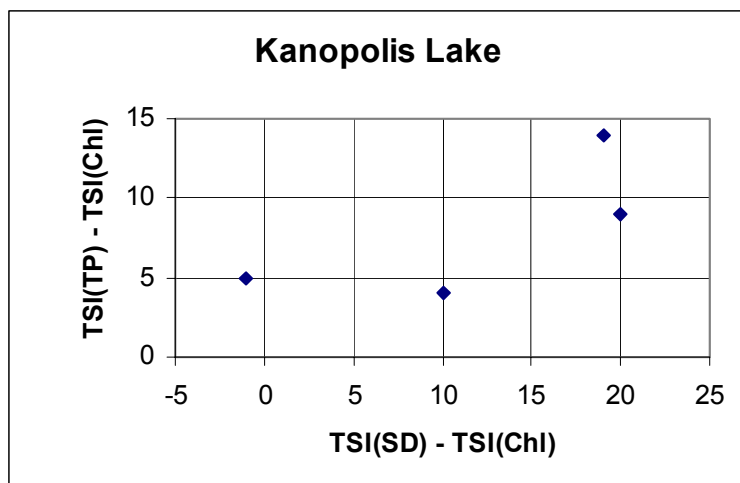
Liscek, Bonnie C. Methodology Used in Kansas Lake TMDLs [web page] Jul. 2001; <http://www.kdhe.state.ks.us/tmdl/eutro.htm> [Accessed 30 September 2002].

Mankin, Kyle. Smoky Hill River Watershed Assessment Project. 2003.

Appendix A - Boxplots

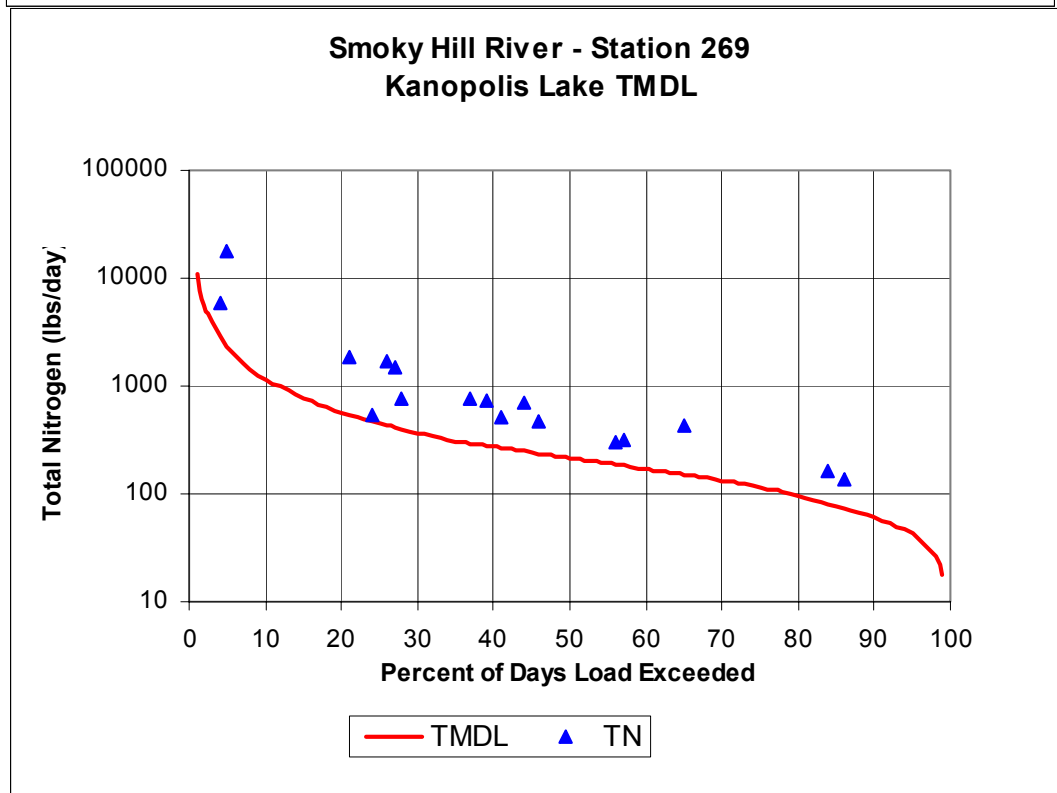
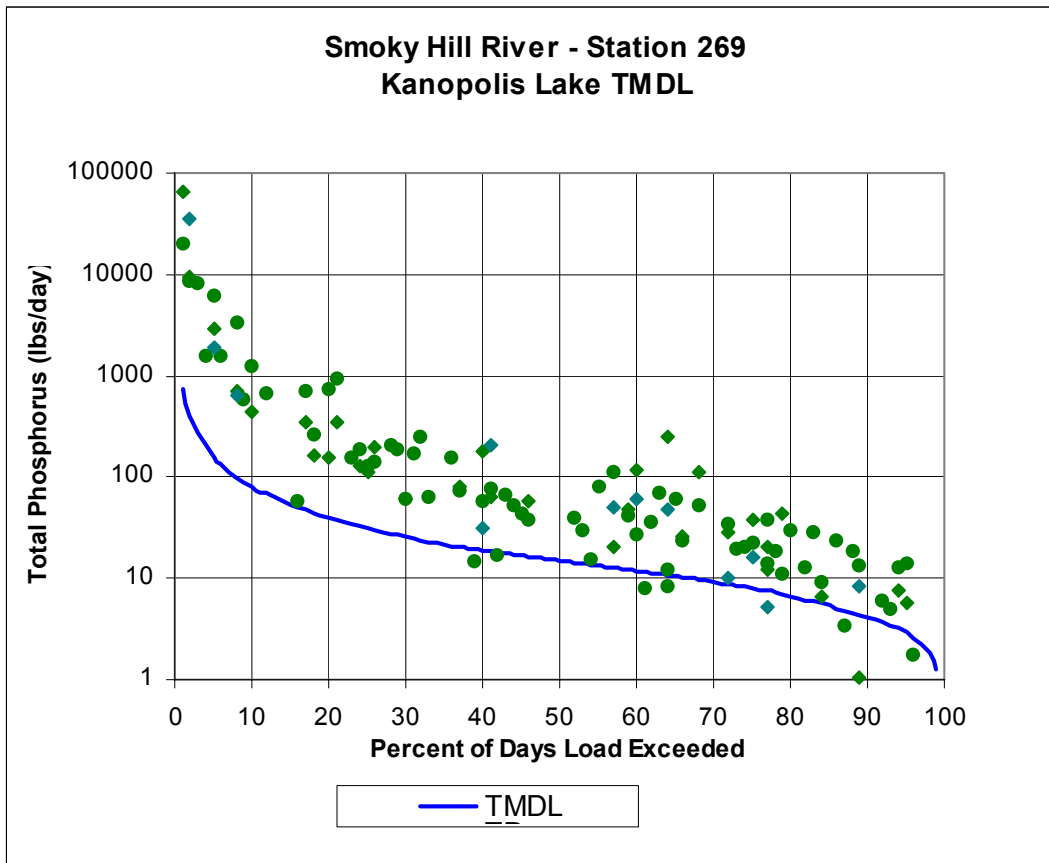


Appendix B - Trophic State Index Plots



The Trophic State Index plots indicate that light is the primary limiting factor, due to clay turbidity. This is inferred by examining the relationship between the TSI(SD) - TSI(Chl) and TSI(TP)-TSI(Chl). The deviation of chlorophyll from the sediment load indicates the degree of light penetration, while the difference between chlorophyll and phosphorus indicates the level of phosphorus limitation. Therefore, if the final plot is in the first quadrant, it shows that the transparency of the water is impaired due to the presence of small particles, and that phosphorus does not limit algae growth. The positive slope of the graph also indicates a correlation between phosphorus and transparency which is found when phosphorus is bound to non algal particles. The relationship between the TSI(SD) - TSI(Chl) and TSI(TN)-TSI(Chl) indicates that nitrogen may be a secondary limiting factor.

Appendix C - Load Reduction Curves



Appendix D - Input for CNET Model

Parameter	Value Input into CNET Model
Drainage Area (km ²)	6253
Precipitation (m/yr)	0.66
Evaporation (m/yr)	1.58
Unit Runoff (m/yr)	0.04
Surface Area (km ²)	15.1
Mean Depth (m)	4.0
Depth of Mixed Layer (m)	3.9
Depth of Hypolimnion (m)	1.1
Observed Phosphorus (ppb)	80.0
Observed Chlorophyll-a (ppb)	24.2
Observed Secchi Disc Depth (m)	0.9

Output from CNET Model

Parameter	Output from CNET Model
Load Capacity (LC)*	73,920 lb/yr
Waste Load Allocation (WLA)	50,331 lb/yr
Load Allocation (LA)	16,197 lb/yr
Margin of Safety (MOS)	7,392 lb/yr

*LC = WLA + LA + MOS

Appendix E- Wasteload Allocations

Permit Number	Facility Name	Design Flow (MGD)	Current Condition				Wasteload Allocation			
			TP (mg/L)	Load (lb/day)	TN (mg/L)	Load (lb/day)	TP (mg/L)	Load (lb/day)	TN (mg/L)	Load (lb/day)
M-SH16-OO02	HAYS WWTF	2.800	5.2	121.58	21.6	505.0	3.5	81.83	20	467.60
M-SH31-OO02	RUSSELL WWTP	1.400	2	23.38	7	81.83	2	23.38	7	81.83
M-SH07-OO01	ELLSWORTH WWTF	0.500	2	8.35	7	29.23	2	8.35	7	29.23
M-SH38-OO01	WAKEENEY MWTP	0.431	3.5	12.60	20	71.98	3.5	12.60	20	71.98
M-SH06-OO02	ELLIS WWTF	0.300	3.5	8.77	20	50.10	3.5	8.77	20	50.10
M-SH40-OO01	WILSON MWTP	0.090	2	1.50	7	8.77	2	1.50	7	8.77
M-SH10-OO01	GORHAM MWTP	0.063	2	1.05	7	3.66	2	1.05	7	3.66
M-SH26-OO02	McCRACKEN MWTP	0.035	2	0.58	7	2.05	2	0.58	7	2.05
Total		5.619		177.80		752.6		138.06		715.20

Approved Aug. 7, 2003